



Rain-on-snow and ice layer formation detection using passive microwave radiometry: An arctic perspective

*Alexandre Langlois^{1,2}
Prof. Université de Sherbrooke*

*Alain Royer^{1,2}, Benoît Montpetit³, Cheryl-Ann Johnson⁴, Ludovic Brucker⁵,
Caroline Dolant^{1,2}, Agnes Richards⁶, Alexandre Roy^{1,2}*

*¹Centre d'Applications et de Recherches en Télédétection (CARTEL), Université de
Sherbrooke, Quebec, Canada.*

²Centre d'étude nordiques, Quebec, Canada

³Canadian Ice Service, Ottawa, ON, Canada

⁴Canadian Wildlife Service, Environment Canada, Ottawa, ON

⁵ NASA Goddard, Greenbelt, USA

⁶ Canadian Center for Inland Waters, Env. Can., Toronto, Canada





Rain-on-snow and ice layer formation detection using passive microwave radiometry: An arctic perspective

Outline

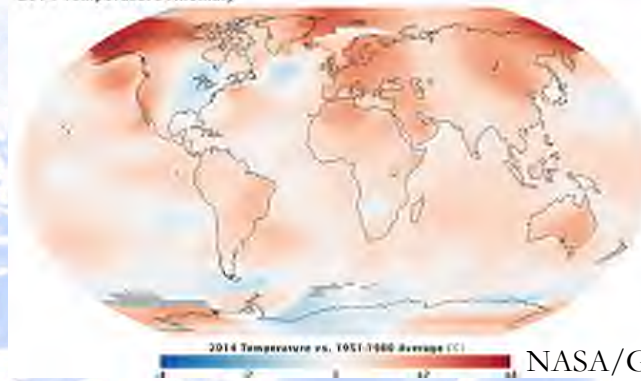
PART I: Arctic context

1. Motivation and study sites
2. Algorithm development

PART II: Some occurrence numbers 1979-2011

3. Rain-on-snow
4. Ice layers
5. Perspective





PART I :Arctic context

1. Motivation and study sites

- increased occurrence of rain-on-snow
- increased occurrence of strong wind events
 - ➔ both leading to snow densification
- Changing rapidly, with significant consequences:
 - Grazing conditions under ice for ungulates;
 - Changes in snow cover affects permafrost and sea ice regimes.
- Need for global information of snow information
 - Passive microwave remote sensing;
 - Snow modeling / climate model coupling.

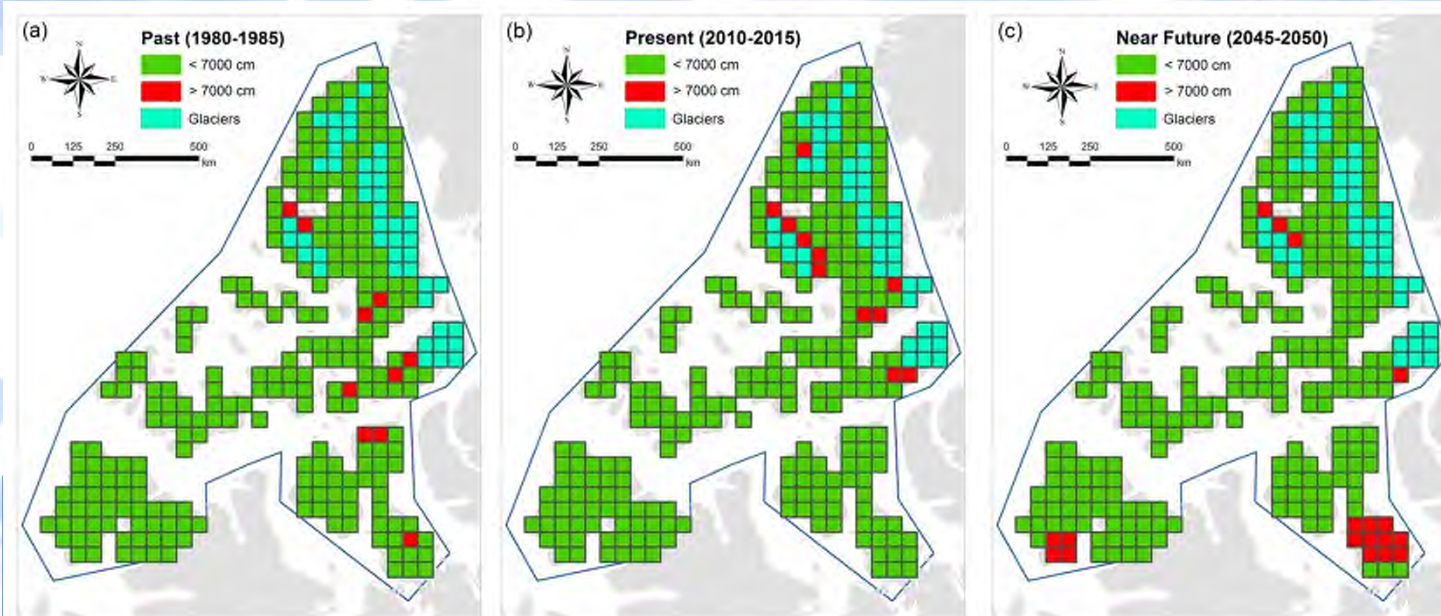
ROS events are projected to be more frequent over a wider spatial extent (Semmens et al., 2013): need for a satellite-based detection approach



PART I :Arctic context

1. Motivation and study sites

- Peary caribou population affected by snow conditions:



Ouellet et al., 2015

Need to develop ROS and ice tracking approaches in the Arctic...



PART I :Arctic context

2. Algorithm development: ROS

- Empirical approach from case study: January 30th – February 2nd 2013:

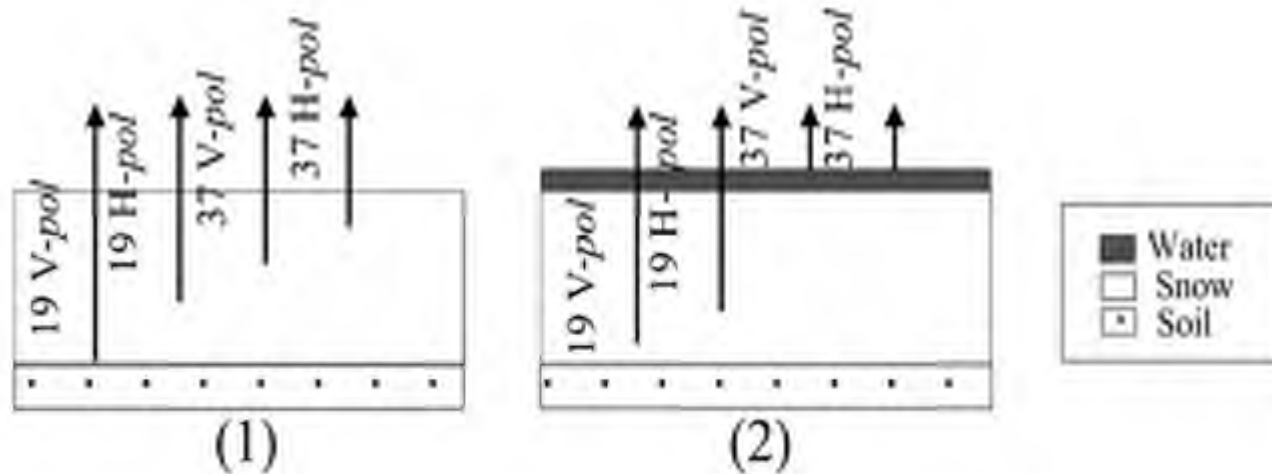


Figure 5: General scheme of the snow microwave response;
(1) basic snowpack, (2) snowpack with ice crust or wet snow

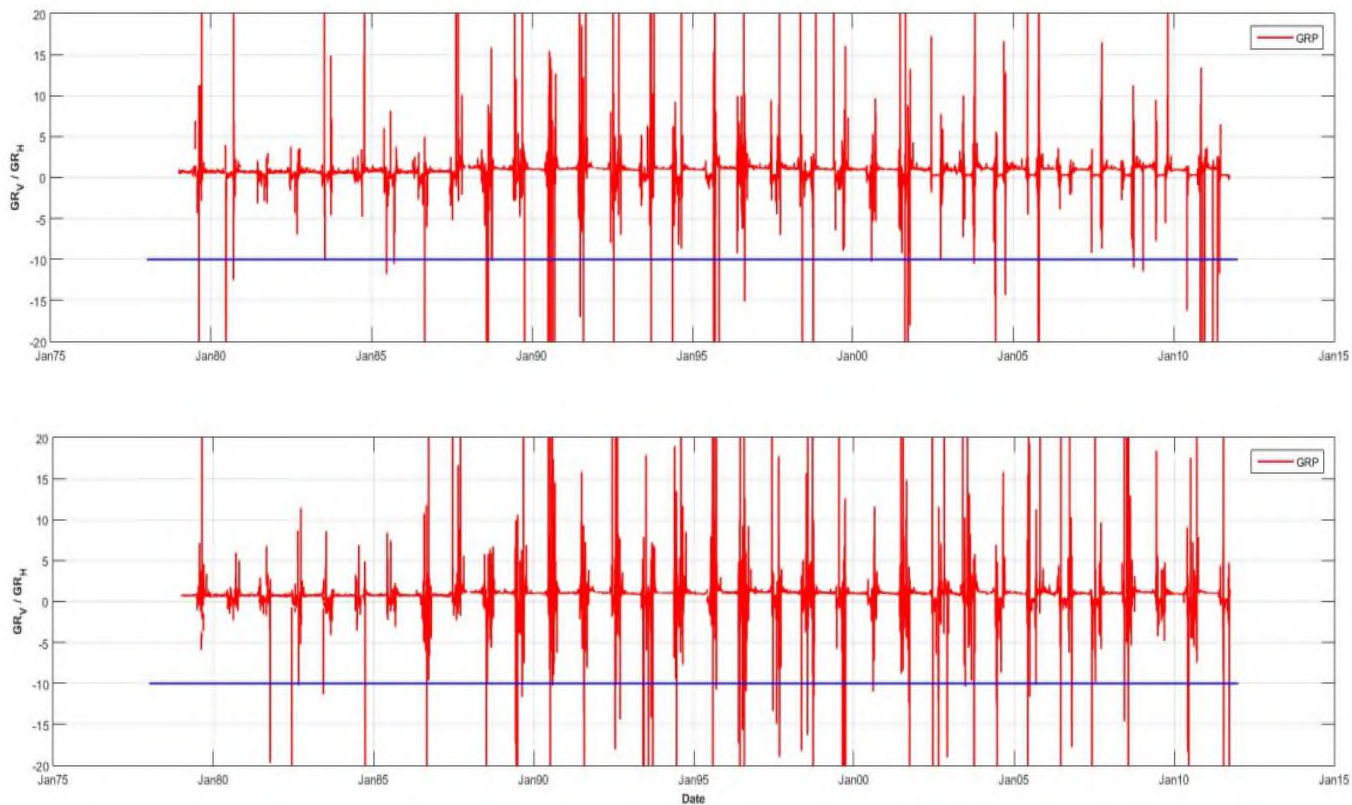
Dolant et al., 2015





PART I: Arctic context

2. Algorithm development: ROS



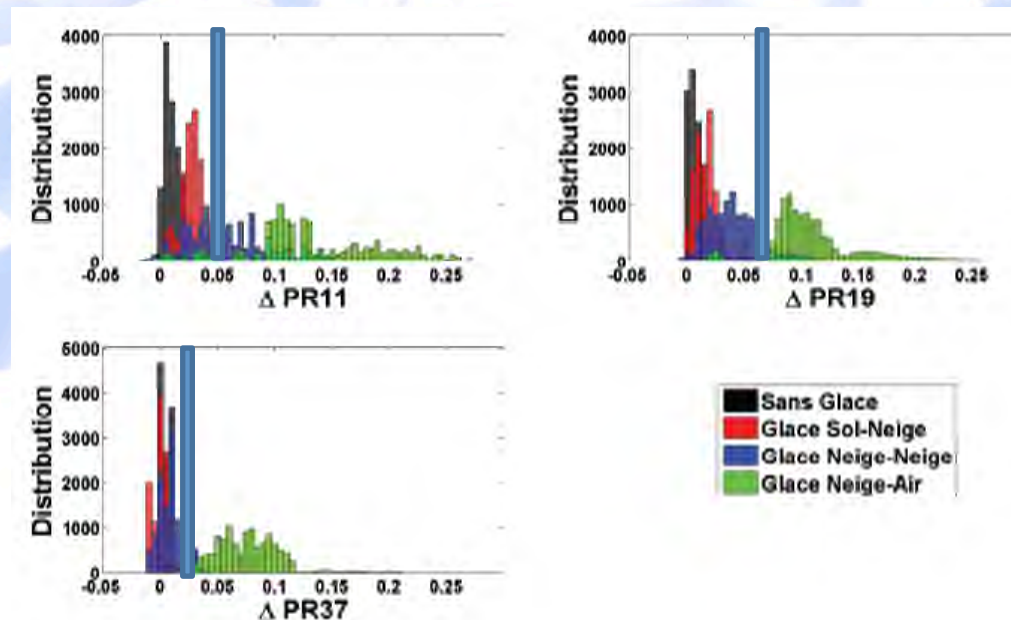
PART I: Arctic context

2. Algorithm development: Ice Detection Index (IDI)

Polarization ratio (PR):

$$PR(f) = \frac{T_B(f, V - Pol) - T_B(f, H - Pol)}{T_B(f, V - Pol) + T_B(f, H - Pol)}$$

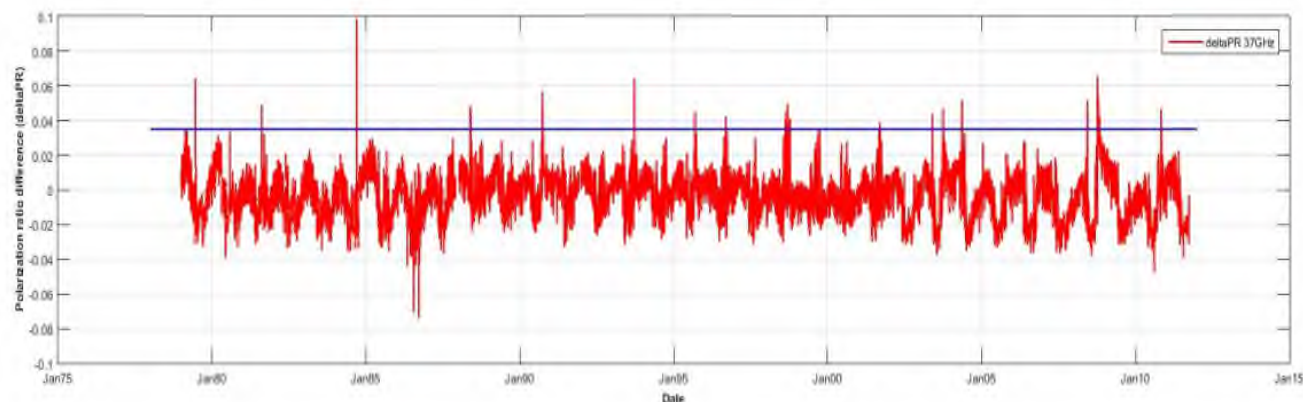
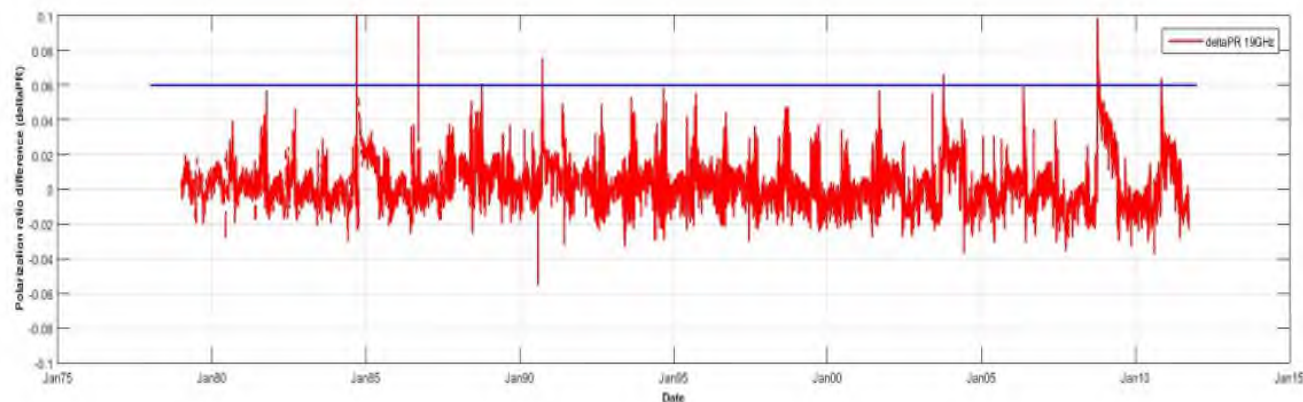
Horizontal polarization more sensitive to ice layers and vertical dielectric contrast, threshold established from the following (PR simulated with ice vs PR without ice):





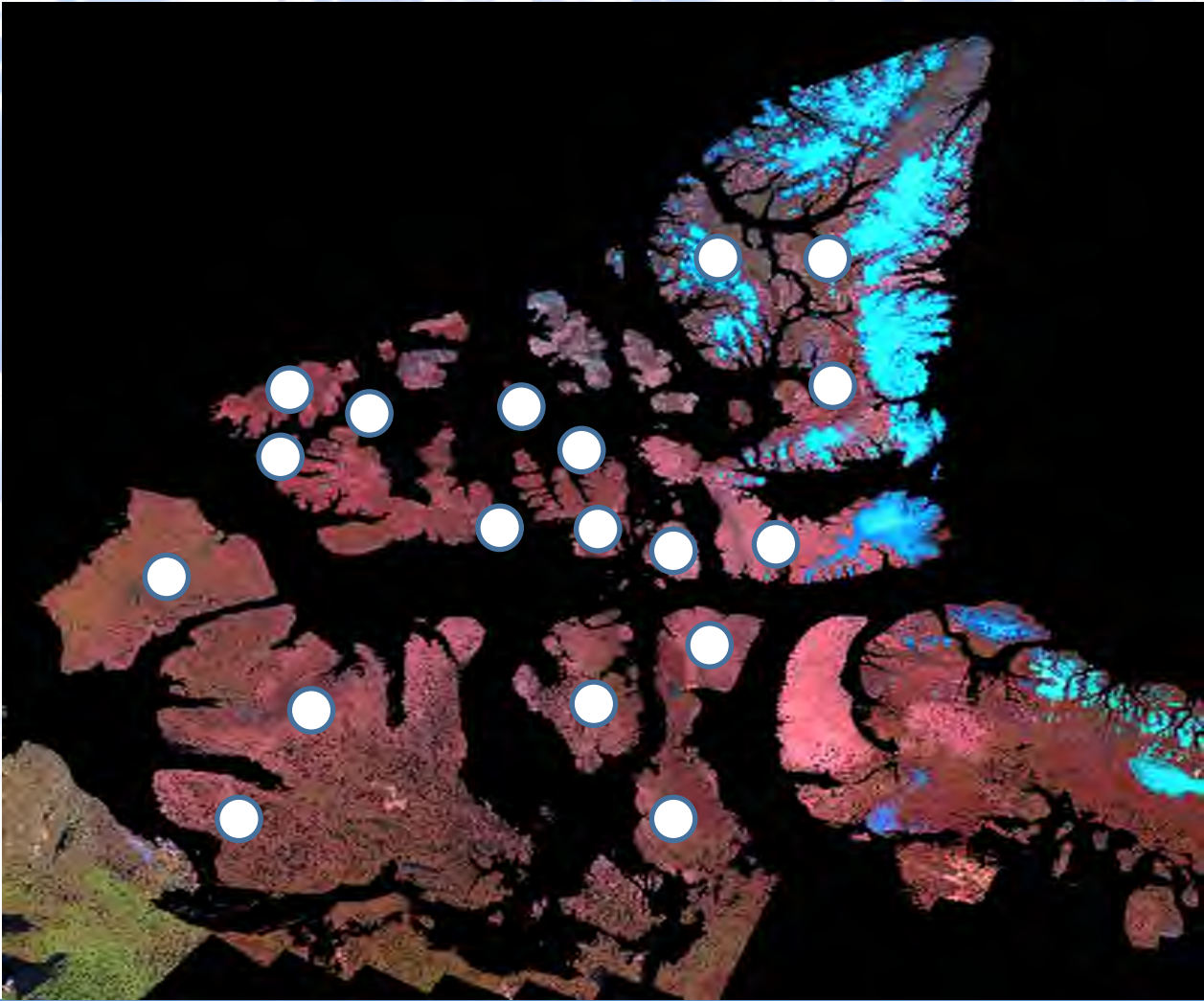
PART I: Arctic context

2. Algorithm development: Ice Detection Index (IDI)





PART II: Occurrence numbers





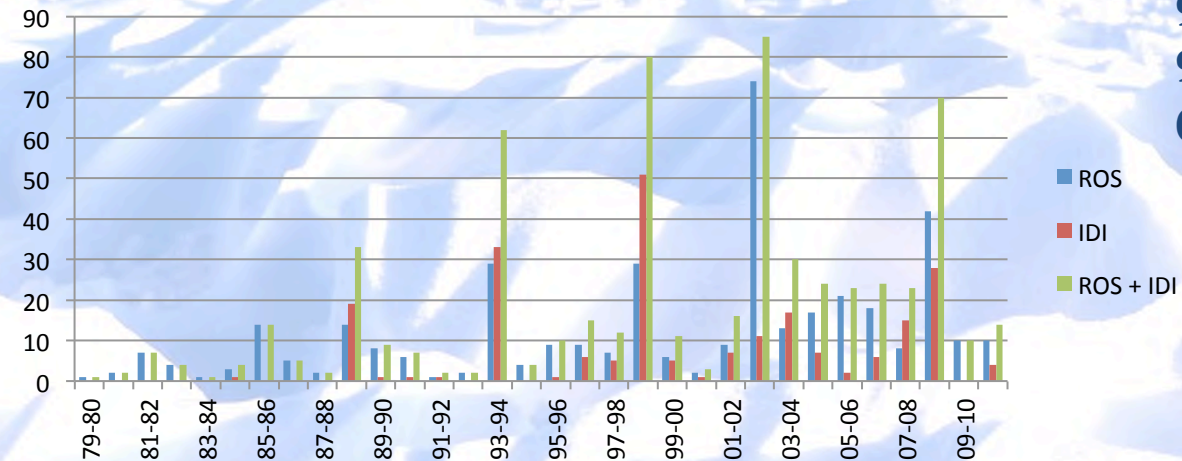
PART II: Occurrence numbers

	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	Totals 79-95	
BP%	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0	13	
PW%	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	4	
SI%	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	5	
AH%	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	
SE%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	
CE%	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	
MI%	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5	
PP%	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	
Eg%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Em%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BM%	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2	
DI%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
LI%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
CI%	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	3	
HI%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BIC%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BI%	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0	13	
VI%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Totals	0	0	0	0	0	1	0	0	0	15	1	1	1	0	21	0	30	
	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	Totals 95-11	1974-2011
BP%	0	0	2	2	0	0	0	0	0	0	0	0	12	0	0	0	16	32
PW%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SI%	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
AH%	0	0	0	0	0	0	0	10	0	7	0	0	0	0	0	0	17	19
SE%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CE%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MI%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PP%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eg%	0	0	0	0	0	0	0	1	1	0	0	0	0	3	0	0	5	5
Em%	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	6	6
BM%	0	3	0	20	0	0	3	0	0	0	0	0	0	0	0	0	26	30
DI%	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1
LI%	0	0	0	13	0	0	0	0	0	0	0	0	0	4	0	0	20	20
CI%	0	2	0	6	5	0	3	0	0	0	0	0	0	5	0	0	19	22
HI%	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	6	7
BIC%	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
BI%	0	0	2	2	0	0	0	0	7	0	0	0	0	3	0	0	14	17
VI%	0	0	0	0	0	0	0	0	0	0	2	6	0	10	0	1	27	27
Totals	0	6	5	41	5	1	3	11	17	7	2	6	18	25	0	1	166	192





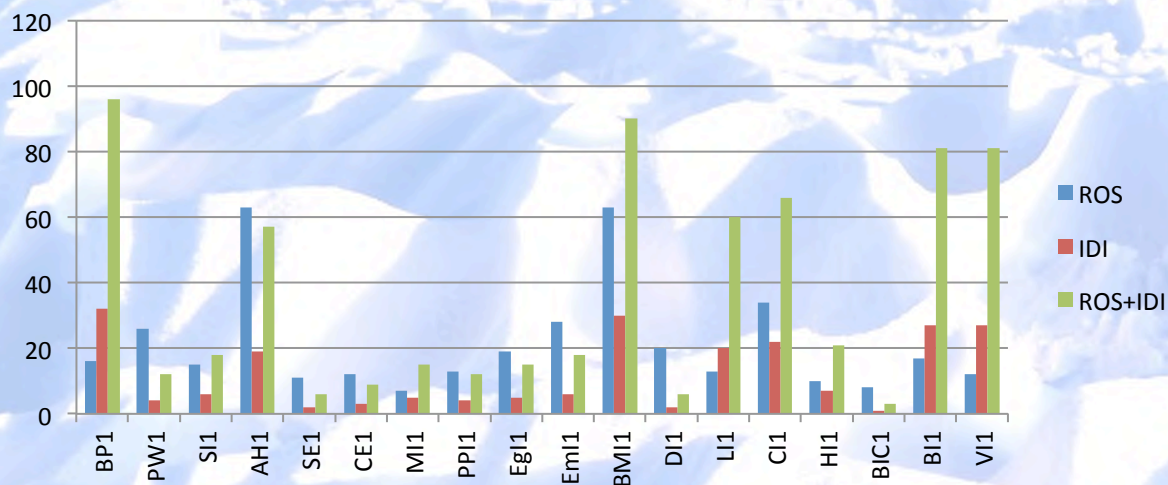
PART II: Occurrence numbers



93-94: BI, BP
98-99: BM, LI, CI, HI
02-03: AH, Em



PART II: Occurrence numbers



Islands with most combined occurrences:

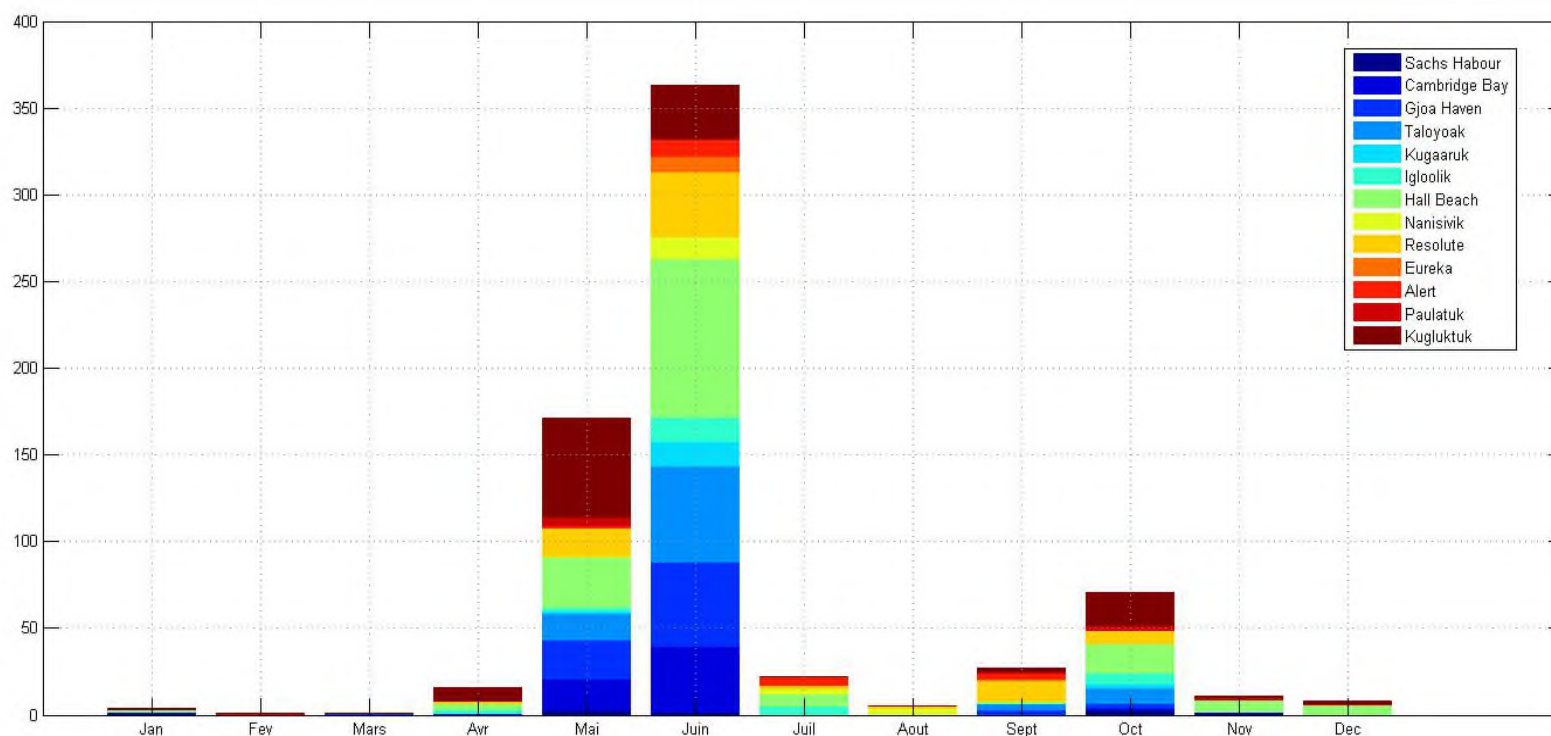
- Boothia Peninsula (Ouellet et al., 2015 – SNOWPACK)
- Axel Heiberg
- Byram Martin
- Loughheed + Cornwallis
- Banks + Victoria





Future outcome and concluding remarks

- More on GRP threshold, with observed events:





Future outcome and concluding remarks

Plans for 2016:

- Dysdrometer installation in Cambridge Bay along with passive microwave radiometers (19-37-89 GHz);
- More on climatology assessment, tracking origin of ROS and LPDs;
- New PhD student working on the modeling of ROS-snow interactions using the SNOWPACK model.



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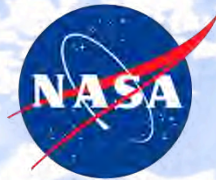
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National Aeronautics and Space Administration (NASA)

Mitacs scholarship program

Hydro-Québec

Polar Continental shelf Program



National Search and Rescue
Secretariat



Environment
Canada

Environnement
Canada

